JC18 Rec'd PCT/PTO 2001

FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 2854

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR): 10/019512

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE00/01163	12 April 2000	29 April 1999

TITLE OF INVENTION

RECORDING METHOD AND ASSOCIATED PHOTOGRAMMETRIC CAMERA

APPLICANT(S) FOR DO/EO/US

TEUCHERT, Wolf D.

MAYR, Werner

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☑ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☑ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include itens (5), (6), (9) and (24) indicated below.
4. ☑ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☑ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☑ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☑ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☑ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☑ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☑ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☑ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☑ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☑ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☑ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☑ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☑ Certificate of Mailing by Express Mail
23. ☑ Other items or information:

    Express Mail # EL 857054095 US

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
10/019512	PCT/DE00/01163	2854

24. The following fees are submitted:		CALCULATIONS PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :		
☑ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO	**$1040.00**	
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO	**$890.00**	
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	**$740.00**	
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4)	**$710.00**	
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4)	**$100.00**	
ENTER APPROPRIATE BASIC FEE AMOUNT =		**$1,040.00**
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).		**$0.00**

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	9 - 20 =	0	x $18.00	**$0.00**
Independent claims	2 - 3 =	0	x $84.00	**$0.00**
Multiple Dependent Claims **(check if applicable).**			☐	**$0.00**
TOTAL OF ABOVE CALCULATIONS =				**$1,040.00**
☑ Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.				**$520.00**
SUBTOTAL =				**$520.00**
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				**$0.00**
TOTAL NATIONAL FEE =				**$520.00**
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐				**$0.00**
TOTAL FEES ENCLOSED =				**$520.00**
			Amount to be: refunded	$
			charged	$

a. ☐ A check in the amount of _____ to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **08-0114** A duplicate copy of this sheet is enclosed.

d. ☒ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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Tel: (949) 851-5010
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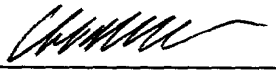

SIGNATURE

Walter A. Hackler, Ph.D.

NAME

27,792

REGISTRATION NUMBER

October 25, 2001

DATE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Wolf D. Teuchert et al	)Examiner
Serial No.:	Unknown	)
Filed:	Unknown	)Group Art
For:	RECORDING METHOD AND ASSOCIATED PHOTOGRAMMETRIC CAMERA	)3626)

October 2001

PRELIMINARY AMENDMENT

Assistant Comm for Patents
Washington, D.C. 20231

Dear Sir:

Please amend the hereinabove referenced and accompanying patent application as follows before calculation of filing fees and examination.

IN THE SPECIFICATION

Please replace the paragraph beginning on page 4 at line 19 with the following paragraph:

Figs. 2a-2c show different embodiments of detection groups.

Please replace the paragraph beginning on page 4 at line 21 with the following paragraph:

Figs. 3a-3b show the recording situation of a terrain strip on the ground or of any surface segment of two different, but immediately following recording times; and

Please replace the paragraph beginning on page 5 at line 32 with the following paragraph:

Figs. 3a-3b show that a certain strip of terrain 10 is pictured at a first point in time (Fig. 3a) onto the front detectors 7a of the detector group (e.g. 41) disposed in the front detector strip extending transverse to the direction of flight 3 and are recorded and digitally stored as incomplete first individual picture. At a slightly later point in time (Fig.3b), when the detector group 42 has moved forward in the direction of flight 3, this terrain strip 10 is again recorded by the detector group 41 as incomplete second individual picture, however by the rear detectors 7b and digitally stored. Since the rear detectors 7b leave a gap to the front detectors 7a in the direction of flight 3, the two individual

Please replace the paragraph beginning on page 6 at line 5 with the following paragraph:

Figs. 4a-4b show a multi-head camera 12 comprising six camera heads 13a to 13f of which one pair 13a, 13b is directed to the front, one pair 13c, 13d is directed to Nadir and one pair 13e, 13f is directed to the rear. A camera head (13a, 13c, 13e) of each pair is directed to the right, viewed in the direction of flight 3, and one (13b, 13d, 13f) is directed to the left. The outer camera heads 13a, 13b and 13e, 13f contain black/white detectors for optimum performance at aerotriangulation, whereas the Nadir cameras 13c, 13d disposed in the center are provided with color detectors which have a color pattern e.g. in red, green and blue, e.g. Bayer pattern RGGB. This permits production of e.g. colored orthophotos of optimum quality.

Please replace the paragraph beginning on page 4 at line 24 with the following paragraph:

Figs. 4a-4b show a photogrammetric camera including six camera heads, viewed from below through the optical window (Fig. 4a) and their orientation transverse to the direction of flight (Fig. 4b).

Please replace the paragraph beginning on page 4, line 30 with the following paragraph:

Fig. 1 schematically shows an inventive photogrammetric camera 1 which is disposed in an aircraft (not shown) and flies in the direction of flight 3 over terrain 2 symbolically shown through the horizon. The camera 1 comprises three electro-optical detector groups 4a, 4b, 4c which are separated from one another in the direction of flight 3. The outer detector groups 4a, 4c are oriented to the front or rear and the central detector group 4b is oriented to the Nadir. One terrain region 6a, 6b, 6c is pictured on the individual detector groups 4a, 4b, 4c via a projection lens 5 which can consist of an array of individual objectives in accordance with Figs. 4a and 4b.

Please replace the paragraph beginning on page 5 at line 1 with the following paragraph:

As further explained below, each detector group 4a, 4b, 4c comprises several detectors 7 separated from one another (e.g. CCD detectors) which are disposed such that, viewed in the direction of flight 3, at least one detector

7 at least partly covers the gap 8 between two neighboring detectors separated from one another transverse to the direction of flight 3. At the moment shown in Fig. 1, the detector group 4a, 4b, 4c electro-optically records and stores the full surface of each terrain region 6a, 6b, 6c, however, the individual picture is incomplete due to the gaps 8 between the individual detectors 7. It is decisive that no picture connection of the individual detector groups 4a, 4b, 4c in the direction of flight 3 is required.

Please replace the paragraph beginning on page 5 at line 10 with the following paragraph:

Figs. 2a-2c show three different embodiments of detector groups 41, 42, 43 with electro-optical detectors 7 of different arrangements which are each surrounded by a lateral outer border 9. The detectors 7 of the detector group 41 (Fig. 2a), viewed in the direction of flight 3, have a smaller separation from one another in their bordering region than at their center. This produces gaps 8 of different sizes which are larger in the center than in the border regions. The detectors 7 of the detector group 42 (Fig. 2b) are - compared to the detector group 41 - distributed more uniformly across their entire surface and, in particular, also disposed in their center. However, also the gaps 8 have different sizes. The detector group 43 (Fig.2c) shows a completely uniform arrangement of the detectors 7 in the direction of flight 3 with identical gap pattern. While the detector groups 41 and 42 comprise 20 detectors 7 each, the detector group 43 has a total of 25 detectors 7.

IN THE CLAIMS

Please amend claims 1, and 3-8 as follows:

1. (Amended) Method for recording pictures of a terrain or surface from the air, wherein several individual pictures of a terrain or surface region, taken from the air, are successively electro-optically recorded and digitally stored, and combined into a total picture of the terrain or surface region, the method comprising the steps of:

recording individual pictures of a full area of the terrain or surface region to be recorded with different gaps in the pictures; and

digitally superposing at least two individual pictures by means of coinciding picture sections to obtain the total picture of the terrain or surface region.

3. (Amended) Photogrammetric camera for the detection of terrain or surface, the camera comprising:

a plurality of electro-optical detectors disposed in at least one detector group, wherein;

the detector group includes a plurality of separated detectors, the detectors being separated both longitudinally and transversely from one another, at least one longitudinally spaced detector covers at least part of a transverse gap between two neighboring detectors separated in the transverse direction.

4. (Amended) Photogrammetric camera according to claim 3, wherein neighboring detectors of the detector group have a smaller separation from one another in a border region than in a center region.

5. (Amended) Photogrammetric camera according to claim 3, wherein detectors border regions of the detector group have a higher resolution than detectors in a center region.

6. (Amended) Photogrammetric camera according to claim 3, further comprising at least three detector groups disposed longitudinally from one another, a the central detector group being designed for color recordings and the other detector groups being designed for black white recordings.

7. (Amended) Photogrammetric camera according to claim 3, wherein at least one detector group is attached to a camera.

8. (Amended) Photogrammetric camera according to claim 3, wherein neighboring detectors of each detector group have a smaller separation from one another in a border region than in a center region, wherein detectors in the border regions of the detector group have a higher resolution than detectors in the center region, wherein at least three detector groups are disposed in a direction of flight of which the central region is designed for color recordings and disposed in a direction of flight of which the central region is designed for color recordings and two other regions are designed for black,/white recordings, and wherein the at least one detector group is attached to a camera.

REMARKS

The present amendment is made to place the application into conformity with U.S. practices. No new matter has been added.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE."

Respectfully submitted,

Walter A. Hackler, Reg. No. 27,792
Attorney of Record
2372 S.E. Bristol - Ste. B.
Newport Beach, CA 92660
(949) 851-5010

VERSION WITH MARKINGS SHOWING CHANGES MADE

IN THE SPECIFICATION

Please replace the paragraph beginning on page 4 at line 19 with the following paragraph:

~~Fig. 2~~Figs. 2a-2c ~~shows~~show different embodiments of detection groups.

Please replace the paragraph beginning on page 4 at line 21 with the following paragraph:

~~Fig. 3~~Figs. 3a-3b ~~shows~~ show the recording situation of a terrain strip on the ground or of any surface segment of two different, but immediately following recording times; and

Please replace the paragraph beginning on page 5 at line 32 with the following paragraph:

~~Fig. 3 shows~~Figs. 3a-3b show that a certain strip of terrain 10 is pictured at a first point in time (Fig. 3a) onto the front detectors 7a of the detector group (e.g. ~~4a~~41) disposed in the front detector strip extending transverse to the direction of flight 3 and are recorded and digitally stored as incomplete first individual picture. At a slightly later point in time (Fig.3b), when the detector group 42 has moved forward in the direction of flight 3, this terrain strip 10 is again recorded by the detector group ~~4a~~41 as incomplete second individual picture, however by the rear detectors 7b and digitally

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~~Fig. 4 shows~~Figs. 4a-4b show a multi-head camera 12 comprising six camera heads 13a to 13f of which one pair 13a, 13b is directed to the front, one pair 13c, 13d is directed to Nadir and one pair 13e, 13f is directed to the rear. A camera head (13a, 13c, 13e) of each pair is directed to the right, viewed in the direction of flight 3, and one (13b, 13d, 13~~d~~f) is directed to the left. The outer camera heads 13a, 13b and 13e, 13f contain black/white detectors for optimum performance at aerotriangulation, whereas the Nadir cameras 13c, 13d disposed in the center are provided with color detectors which have a color pattern e.g. in red, green and blue, e.g. Bayer pattern RGGB. This permits production of e.g. colored orthophotos of optimum quality.

Please replace the paragraph beginning on page 4 at line 24 with the following paragraph:

~~Fig. 4~~Figs. 4a-4b ~~shows~~ show a photogrammetric camera including six camera heads, viewed from below through the optical window (Fig. 4a) and their orientation transverse to the direction of flight (Fig. 4b).

Please replace the paragraph beginning on page 4, line 30 with the following paragraph:

Fig. 1 schematically shows an inventive photogrammetric camera 1 which is disposed in an aircraft (not shown) and flies in the direction of flight 3 over terrain 2 symbolically shown through the horizon. The camera 1 comprises three electro-optical detector groups 4a, 4b, 4c which are separated from one another in the direction of flight 3. The outer detector groups 4a, 4c are oriented to the front or rear and the central detector group 4b is oriented to the Nadir. One terrain region 6a, 6b, 6c is pictured on the individual detector groups 4a, 4b, 4c via a projection lens 5 which can consist of an array of individual objectives in accordance with ~~Fig. 4.~~Figs. 4a and 4b.

Please replace the paragraph beginning on page 5 at line 1 with the following paragraph:

As further explained below, each detector group ~~4~~4a, 4b, 4c comprises several detectors 7 separated from one another (e.g. CCD detectors) which are disposed such that , viewed in the direction of flight 3, at least one detector 7 at least partly covers the gap 8 between two neighboring detectors separated from one another transverse to the direction of flight ~~2~~3. At the moment shown in Fig. 1, the detector group 4a, 4b, 4c electro-optically records and stores the full surface of each terrain region 6a, 6b, 6c, however, the individual picture is incomplete due to the gaps 8 between the individual detectors 7. It is decisive that no picture connection of the individual detector groups 4a, 4b, 4c in the direction of flight 3 is required.

Please replace the paragraph beginning on page 5 at line 10 with the following paragraph:

~~Fig. 2~~Figs. 2a-2c show ~~shows~~ three different embodiments of detector groups 41, 42, 43 with electro-optical detectors 7 of different arrangements which are each surrounded by a lateral outer border 9. The detectors 7 of the detector group 41 (Fig. 2a), viewed in the direction of flight 3, have a smaller separation from one another in their bordering region than at their center. This produces gaps 8 of different sizes which are larger in the center than in the border regions. The detectors 7 of the detector group 42 (Fig. 2b) are - compared to the detector group 41 - distributed more uniformly across their entire surface and, in particular, also disposed in their center. However, also the gaps 8 have different sizes. The detector group 43 (Fig.2c) shows a completely uniform arrangement of the detectors 7 in the direction of flight 3 with identical gap pattern. While the detector groups 41 and 42 comprise 20 detectors 7 each, the detector group 43 has a total of 25 detectors 7.

IN THE CLAIMS

Please amend claims 1, and 3-8 as follows:

1. (Amended) Method for recording pictures of a terrain or surface from the air, wherein several individual pictures of a terrain or surface region, taken from the air, are successively electro-optically recorded and digitally stored, and combined into a total picture of the

terrain or surface region, the method comprising the steps of:

recording ~~wherein the~~ individual pictures ~~record the~~of a full area of the terrain or surface region to be recorded~~, however,~~ with different gaps in the pictures; and

~~wherein at least two individual pictures are~~ digitally ~~superposed~~ superposing at least two individual pictures by means of coinciding picture sections to obtain the ~~entire~~total picture of the terrain or surface region.

3. (Amended) Photogrammetric camera for the detection of terrain or surface, ~~with~~ the camera comprising:

a plurality of electro-optical detectors disposed in at least one detector group, wherein;

the detector group ~~has several~~includes a plurality of separated detectors, the detectors being separated both longitudinally and transversely from one another, ~~and wherein, viewed in a certain longitudinal direction (direction of flight) of the detector group~~ at lease one longitudinally spaced detector covers at least part of ~~the~~ a transverse gap between two neighboring detectors separated in the transverse direction.

4. (Amended) Photogrammetric camera according to claim 3, wherein neighboring detectors of the detector group have a smaller separation from one another in ~~the~~ a border region than in ~~the~~ a center region.

5. (Amended) Photogrammetric camera according to claim 3, wherein detectors ~~in the~~ border regions of the

detector group have a higher resolution than detectors in ~~the~~a center region.

6. (Amended) Photogrammetric camera according to claim 3, ~~wherein~~ further comprising at least three detector groups ~~are~~ disposed ~~in the direction of flight of which~~ longitudinally from one another, a the central detector group being~~is~~ designed for color recordings and the other detector groups being~~the two others are~~ designed for black white recordings.

7. (Amended) Photogrammetric camera according to claim 3, wherein ~~the~~ at least one detector group is attached to a camera. ~~known per se, instead of a film tape.~~

8. (Amended) Photogrammetric camera according to claim 3, wherein neighboring detectors of ~~the~~each detector group have a smaller separation from one another in ~~the~~ a border region than in ~~the~~a center region, wherein detectors in the border regions of the detector group have a higher resolution than detectors in the center region, wherein at least three detector groups are disposed in ~~the~~a direction of flight of which the central region is designed for color recordings and disposed in ~~the~~a direction of flight of which the central region is designed for color recordings and ~~the~~ two ~~others~~other regions are designed for black,/white recordings, and wherein the at least one detector group is attached to a camera. ~~known per se, instead of a film tape.~~

5/prts

US-Version

P7311US

Recording Method and Associated Photogrammetric Camera

BACKGROUND OF THE INVENTION

The invention concerns a method for recording pictures, taken from the air, of terrain or a surface (industrial), in particular for air-based or space-based terrestrial picture recordings, wherein several individual pictures, taken from the air, of terrain or a surface region are successively electro-optically recorded and digitally stored and combined into a total picture of the terrain or surface region, and a photogrammetric camera for carrying out this method with several electro-optical detectors disposed to form at least one detector group.

A recording method of this type and such a photogrammetric camera have been disclosed e.g. in DE 197 14 396 A1.

DE 197 14 396 A1 discloses a photogrammetric camera wherein an electro-optical detector group is formed of immediately adjacent sensor lines (detectors) extending transverse to the direction of flight, with a series of individual picture elements or pixels. To obtain a total picture, linear terrain regions (terrain lines) are pictured on the sensor lines at different points in time. In contrast to a trilinear camera, the scanned terrain lines of this photogrammetric camera extend parallel to one another and directly join one another thereby principally improving the evaluation of the line pictures.

It is the object of the invention to further improve the recording method of the above-mentioned type and provide a photogrammetric camera for this purpose.

SUMMARY OF THE INVENTION

This object is achieved in accordance with the invention with the above-mentioned recording method in that the individual pictures record the complete terrain or surface region to be recorded thereby leaving different gaps and that for the total picture of the terrain or surface region, at least two individual pictures are digitally superposed by means of coinciding picture sections.

Preferably, at least two total pictures are recorded from a terrain or surface region each from a different perspective.

To combine several successive individual strip-like pictures, an electronic control permits overlapping of e.g. 50 pixels which permits assembly of same into a picture band in a geometrically stable and completely automatic fashion. This picture band assembly is effected completely automatically for each perspective, e.g. to the front, rear and center (Nadir). A substantial distinctive feature between the invention and trilinear cameras consists in that in a conventional trilinear camera, two-dimensional partial pictures are already present and only these must be subjected to the orientation process. For partial picture stripes of a width of e.g. 1000 pixels, the orientation effort is reduced in accordance with the invention compared to the trilinear camera by the factor 1000 where theoretically each individual one-dimensional line would have to be subjected to the orientation process. This is not realized due to the costs, but with trilinear cameras so-called orientation lines are used for which the orientation parameters are exactly determined. For all intermediate lines, often several hundred lines, the orientation parameters are interpolated with more or less effort, i.e. only approximated orientation parameters are produced, with the trilinear camera, however, exact values. Moreover, the highly precise and expensive INS (InertialNavigationsSystems) units, which are used to support trilinear cameras, can be completely omitted. The two camera groups which are inclined to the front and rear thereby generate stereo picture pairs, whereas the Nadir cameras, disposed in the center, mediate the connection between the photogrammetric models at different locations and usually have a higher resolution. The latter is a decisive, advantageous distinction from the classical (so-called analog) serial photogrammetric cameras.

The basic difference compared to conventional evaluation systems consists also in that the digital pictures are evaluated in accordance with the invention automatically and, on a large scale, on the basis of algorithms. Consequently, the computer carrying out the evaluation must not necessarily obtain a joined digital individual aerial picture which was absolutely required with a classical serial photogrammetric camera. Computers „see" pictures in a mathematical and functional, however, not analog fashion. The computer system can consist of a frame, which is installed in an airplane and contains several industrial PCs. These PCs adopt the digital data from the electro-optical detector groups, supplement the required designations for the current picture block, format and store them e.g. on hard disk batches or tape drives.

To achieve the above-mentioned object, a photogrammetric camera is proposed wherein, in accordance with the invention, one detector group comprises several detectors separated from one another, wherein, viewed from a predetermined longitudinal direction

(direction of flight) of the detector group, at least one detector covers at least part of the gap between two neighboring detectors spaced apart in the transverse direction.

While e.g. with the detector group known from DE 197 14 396 A1 whose entire surface is filled with sensor lines, i.e. with detectors, the inventive electro-optical detector group can do with a smaller detector surface due to the gaps provided between neighboring detectors. This permits more simple production at reduced costs.

In preferred embodiments of the inventive photogrammetric camera, the neighboring detectors have a smaller separation from one another in the border regions of the detector group than in the center, wherein detectors in the border regions of the detector group can have a higher resolution than detectors in the center of the detector group.

Preferably, at least three electro-optical detector groups are provided in the direction of flight of which the central one is designed for color recordings and the two others for black/white recordings.

Preferably, the at least one detector group is attached to a camera known per se instead of a film tape. This camera attachment preferably rests on a base plate which can be attached instead of the film tape e.g. on a serial photogrammetric camera. This permits digital operation of conventional serial photogrammetric cameras at full performance thereby obtaining black/white and colored digital pictures. The camera attachment may bear the detectors which are mutually offset, as described above, and comprises only the actual sensor unit including detector group. The sensor electronics of the camera heads permits compensation of the flight motion (forward motion compensation, FMC) during the picture recording for CCD detectors of a certain construction type. This sensor-close electronics is combined in an electronic unit which can be mounted onto or next to the camera attachment. To obtain precise measurement of the line of sight of the camera, an optional inertial platform must be rigidly connected to the camera attachment. The essential advantage of the digital camera attachment including detector groups consists in the freedom with which the angle of view can be selected, i.e. the angle of the stereo basis which is determined by the outer detector groups to the front and rear.

The focal plane of the camera attachment can contain e.g. a total of 3 double rows including seven CCD detector groups each. The arrangement of the detectors comprising gaps in the direction of flight, facilitates accommodation of the CCDs with the associated sensor electronics in a casing and fully automatic assembly of the pictures of all detectors into a total picture later in the computer.

The photogrammetric camera can be formed as multi-head camera wherein one separate camera head is provided for each detector group. The outer camera heads contain black/white detectors for optimum performance during aerotriangulation whereas the Nadir camera located in the center is provided with color detectors which have a color pattern e.g. in red, green and blue, e.g. Bayer pattern RGGB. This permits production of e.g. colored orthophotos of an optimum quality.

Further advantages of the invention can be extracted from the description and the drawing. The features mentioned above and below can be used in accordance with the invention either individually or collectively in any arbitrary combination. The embodiment shown and described is not to be understood as exhaustive enumeration but rather has exemplary character for describing the invention.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 schematically shows an embodiment of an inventive photogrammetric camera including three detector groups;

Fig. 2 shows different embodiments of detector groups;

Fig. 3 shows the recording situation of a terrain strip on the ground or of any surface segment at two different, but immediately following recording times; and

Fig. 4 shows a photogrammetric camera including six camera heads, viewed from below through the optical window (Fig. 4a) and their orientation transverse to the direction of flight (Fig. 4b).

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

Fig. 1 schematically shows an inventive photogrammetric camera 1 which is disposed in an aircraft (not shown) and flies in the direction of flight 3 over terrain 2 symbolically shown through the horizon. The camera 1 comprises three electro-optical detector groups 4a, 4b, 4c which are separated from one another in the direction of flight 3. The outer detector groups 4a, 4c are oriented to the front or rear and the central detector group 4b is oriented to the Nadir. One terrain region 6a, 6b, 6c is pictured on the individual detector groups 4a,4b,4c via a projection lens 5 which can consist of an array of individual objectives in accordance with Fig. 4.

As further explained below, each detector group 4 comprises several detectors 7 separated from one another (e.g. CCD detectors) which are disposed such that, viewed in the direction of flight 3, at least one detector 7 at least partly covers the gap 8 between two neighboring detectors separated from one another transverse to the direction of flight 2. At the moment shown in Fig. 1, the detector group 4a, 4b, 4c electro-optically records and stores the full surface of each terrain region 6a, 6b, 6c, however, the individual picture is incomplete due to the gaps 8 between the individual detectors 7. It is decisive that no picture connection of the individual detector groups 4a, 4b, 4c in the direction of flight 3 is required.

Fig. 2 shows three different embodiments of detector groups 41, 42, 43 with electro-optical detectors 7 of different arrangements which are each surrounded by a lateral outer border 9. The detectors 7 of the detector group 41 (Fig. 2a), viewed in the direction of flight 3, have a smaller separation from one another in their bordering region than at their center. This produces gaps 8 of different sizes which are larger in the center than in the border regions. The detectors 7 of the detector group 42 (Fig. 2b) are – compared to the detector group 41 – distributed more uniformly across their entire surface and, in particular, also disposed in their center. However, also the gaps 8 have different sizes. The detector group 43 (Fig. 2c) shows a completely uniform arrangement of the detectors 7 in the direction of flight 3 with identical gap pattern. While the detector groups 41 and 42 comprise 20 detectors 7 each, the detector group 43 has a total of 25 detectors 7.

In all detector groups 41,42,43, the detectors 7 are disposed in a loose, but calibrated arrangement and do no longer completely cover a strip extending transverse to the direction of flight 3. Detectors 7a and 7b neighboring in the direction of flight 3 are disposed next to one another thereby leaving a gap 8 such that, viewed in the direction of flight 3, at least one front detector 7a at least partially covers the gap 8 between two neighboring rear detectors 7b separated transverse to the direction of flight 2, or vice versa.

Fig. 3 shows that a certain strip of terrain 10 is pictured at a first point in time (Fig. 3a) onto the front detectors 7a of the detector group (e.g. 4a) disposed in the front detector strip extending transverse to the direction of flight 3 and are recorded and digitally stored as incomplete first individual picture. At a slightly later point in time (Fig. 3b), when the detector group 4a has moved forward in the direction of flight 3, this terrain strip 10 is again recorded by the detector group 4a as incomplete second individual picture, however by the rear detectors 7b and digitally stored. Since the rear detectors 7b leave a gap to the front detectors 7a in the direction of flight 3, the two individual

pictures comprise coinciding picture sections 11 of the terrain strip 10 by means of which the two individual pictures can be aligned to each other and superposed into a digital total picture of the terrain strip 10.

Fig. 4 shows a multi-head camera 12 comprising six camera heads 13a to 13f of which one pair 13a, 13b is directed to the front, one pair 13c, 13d is directed to Nadir and one pair 13e, 13f is directed to the rear. A camera head (13a,13c,13e) of each pair is directed to the right, viewed in the direction of flight 3, and one (13b,13d,13d) is directed to the left. The outer camera heads 13a,13b and 13e,13f contain black/white detectors for optimum performance at aerotriangulation, whereas the Nadir cameras 13c,13d disposed in the center are provided with color detectors which have a color pattern e.g. in red, green and blue, e.g. Bayer pattern RGGB. This permits production of e.g. colored orthophotos of optimum quality.

The essential advantage of the multi-head camera 12 – and the camera 1 – is the freedom of selection of the angle of view, i.e. the angle of the stereo basis which is determined by the inclination of the two outer camera groups to the front and rear. This produces the separation of the recorded picture groups on the ground and hence the number of successively recorded pictures of a series until the scene is completely covered. The partial pictures of the cameras disposed in a line, e.g. the front camera line, have an overlapping which can be determined by the camera arrangement such that a complete two-dimensional picture strip can be automatically produced at the front, rear and in the direction of the Nadir. It is thereby not required to provide complete picture overlapping of approximately 60% as it is the case in classical photogrammetry. Covering of approximately only 50 pixels for the picture connection is sufficient since the three camera groups assume the task of multiple overlapping. The two detector groups disposed to the front and rear thereby generate the stereo picture pairs whereas the Nadir detectors disposed in the center provide the connection between the photogrammetric models at different locations and provide colored orthophotos.

Of course, the multi-head camera can be provided with yet more camera heads, e.g. with nine or more camera heads, preferably in a pattern of 3 x 3.

In a method for recording pictures of terrain 2 from the air, wherein several individual aerial pictures of the terrain region 6a; 6b; 6c are successively electro-optically recorded and digitally stored, and combined into a total picture of the terrain region 6a;6b;6c, the individual pictures record the complete area of the terrain region 6a;6b;6c to be recorded, however, with different gaps 8, and at least two individual pictures are digitally superposed by means of coinciding picture sections 11 to obtain the entire picture of the

terrain region 6a;6b;6c. Towards this end, a photogrammetric camera 1 with at least one detector group 4a, 4b, 4c is used which comprises several detectors 7 disposed at a separation from one another, wherein, viewed in the direction of flight 3, at least one detector 7 at least partially covers the gap 8 between two neighboring detectors 7 separated in the transverse direction.

WE CLAIM:

1. Method for recording pictures of a terrain or surface from the air, wherein several individual pictures of a terrain or surface region, taken from the air, are successively electro-optically recorded and digitally stored, and combined into a total picture of the terrain or surface region, wherein the individual pictures record the full area of the terrain or surface region to be recorded, however, with different gaps and wherein at least two individual pictures are digitally superposed by means of coinciding picture sections to obtain the entire picture of the terrain or surface region.

2. Method according to claim 1, wherein at least two total pictures of a terrain or surface region are recorded each from a different perspective.

3. Photogrammetric camera for the detection of terrain or surface with electro-optical detectors disposed in at least one detector group, wherein the detector group has several separated detectors and wherein, viewed in a certain longitudinal direction (direction of flight) of the detector group at least one detector covers at least part of the gap between two neighboring detectors separated in the transverse direction.

4. Photogrammetric camera according to claim 3, wherein neighboring detectors of the detector group have a smaller separation from one another in the border region than in the center.

5. Photogrammetric camera according to claim 3, wherein detectors in the border regions of the detector group have a higher resolution than detectors in the center.

6. Photogrammetric camera according to claim 3, wherein at least three detector groups are disposed in the direction of flight of which the central is designed for color recordings and the two others are designed for black/white recordings.

7. Photogrammetric camera according to claim 3, wherein the at least one detector group is attached to a camera, known per se, instead of a film tape.

8. Photogrammetric camera according to claim 3, wherein neighboring detectors of the detector group have a smaller separation from one another in the border region than in the center, wherein detectors in the border regions of the detector group have a higher resolution than detectors in the center, wherein at least three detector groups are disposed in the direction of flight of which the central is designed for color recordings and

the two others are designed for black/white recordings, wherein the at least one detector group is attached to a camera, known per se, instead of a film tape.

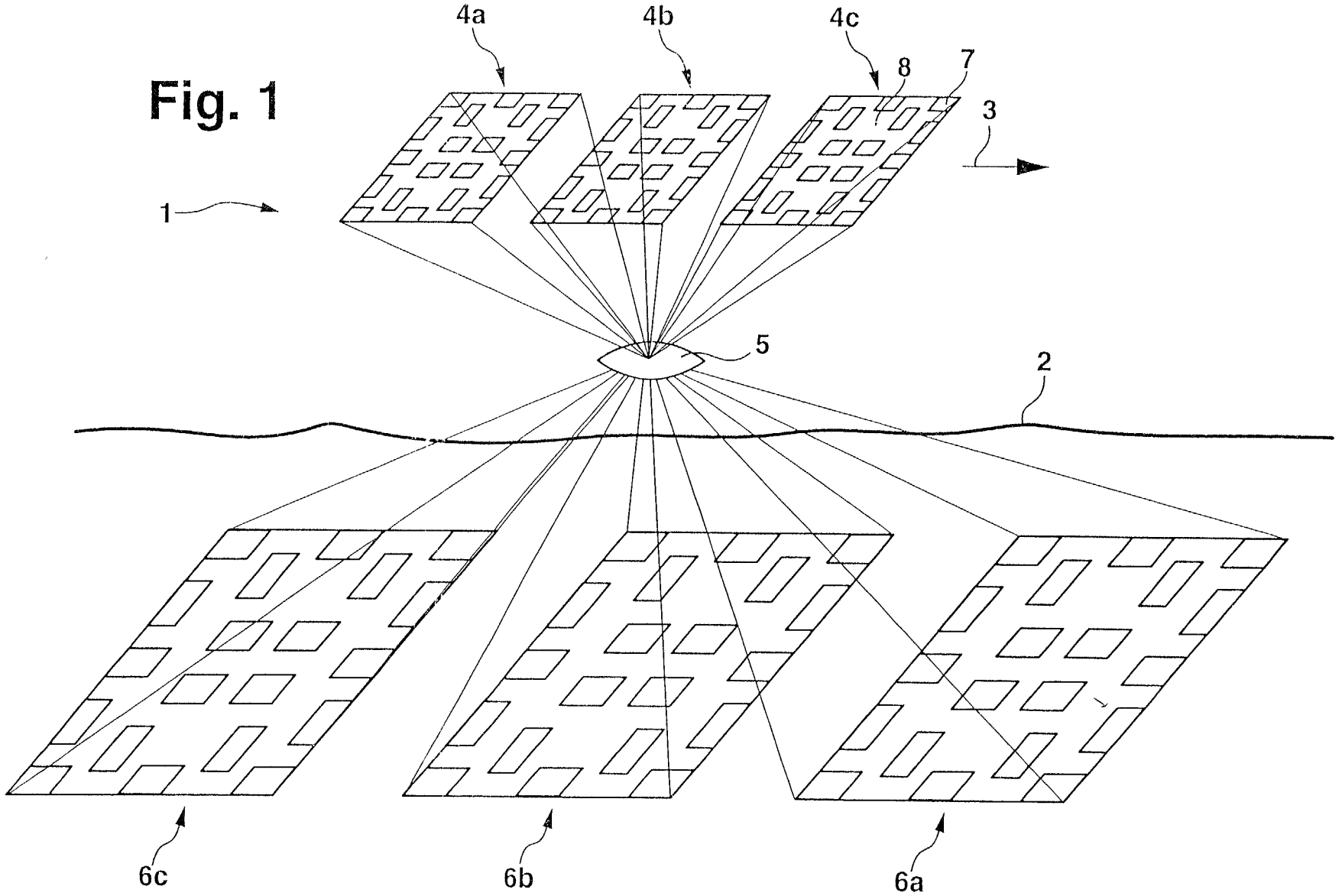
9. Photogrammetric camera according to claim 3, wherein each detector group has its own camera head.

Abstract

In a method for recording pictures of terrain (2) from the air, wherein several individual aerial pictures of the terrain region (6a; 6b; 6c) are successively electro-optically recorded and digitally stored, and combined into a total picture of the terrain region (6a;6b;6c), the individual pictures record the complete area of the terrain region (6a;6b;6c) to be recorded, however, with different gaps (8), and at least two individual pictures are digitally superposed by means of coinciding picture sections (11) to obtain the entire picture of the terrain region (6a;6b;6c). Towards this end, a photogrammetric camera (1) with at least one detector group (4a, 4b, 4c) is used which comprises several detectors (7) disposed at a separation from one another, wherein, viewed in the direction of flight (3), at least one detector (7) at least partially covers the gap (8) between two neighboring detectors (7) separated in the transverse direction.

(Fig. 1)

Fig. 1



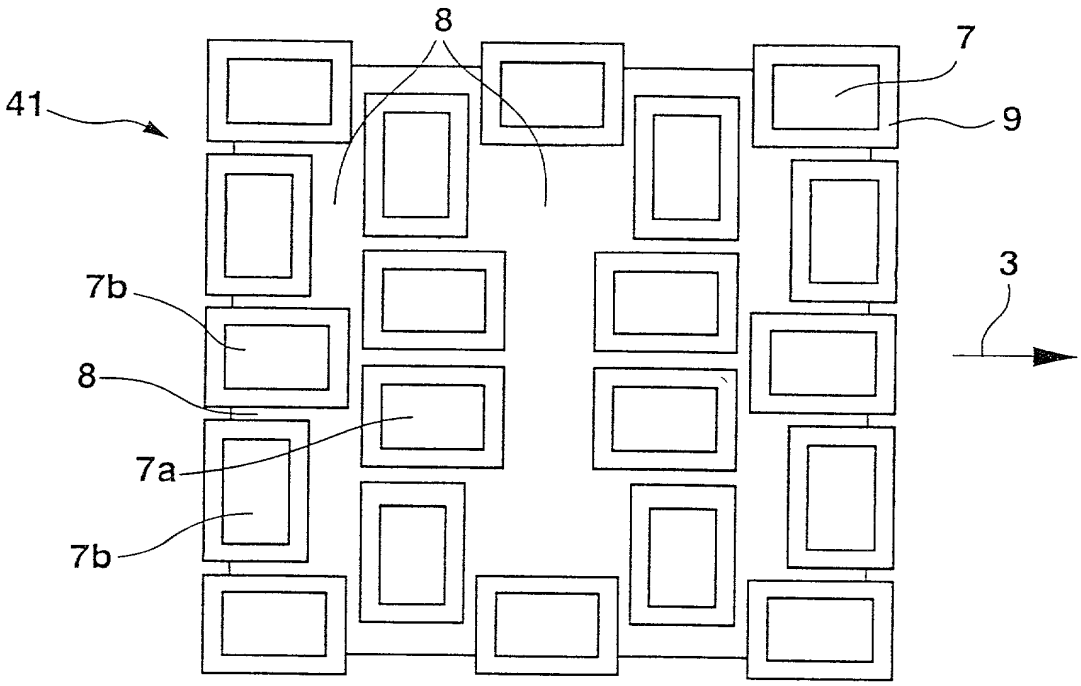


Fig. 2a

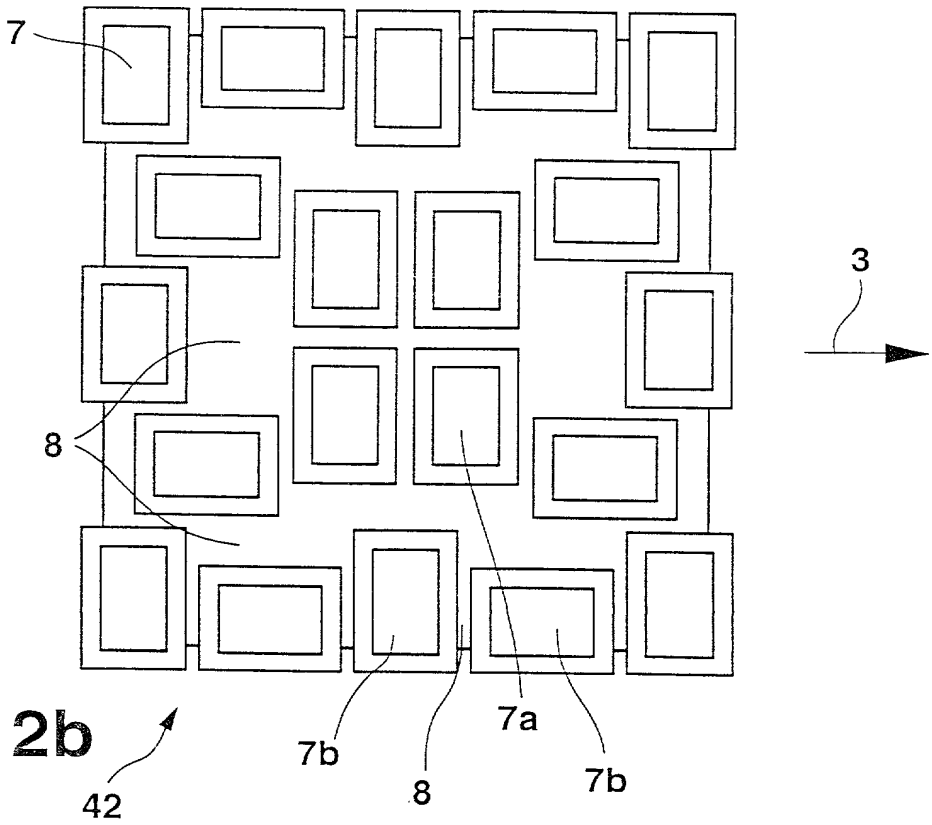


Fig. 2b

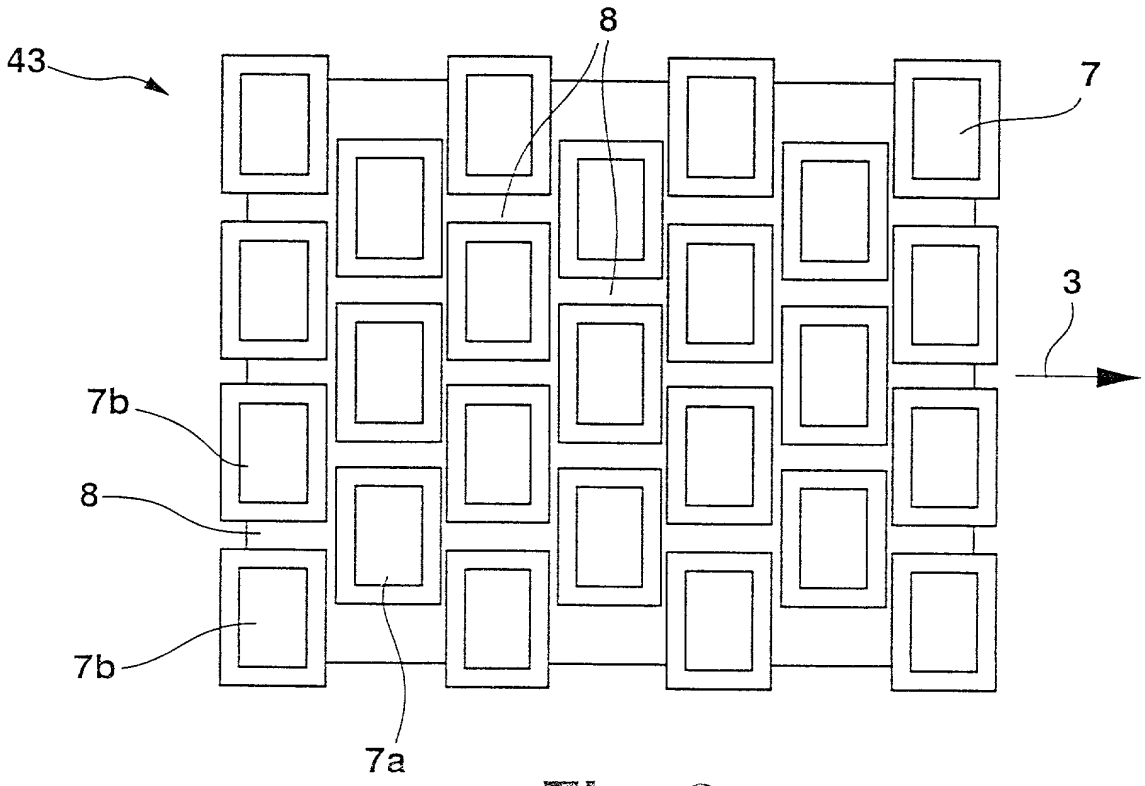


Fig. 2c

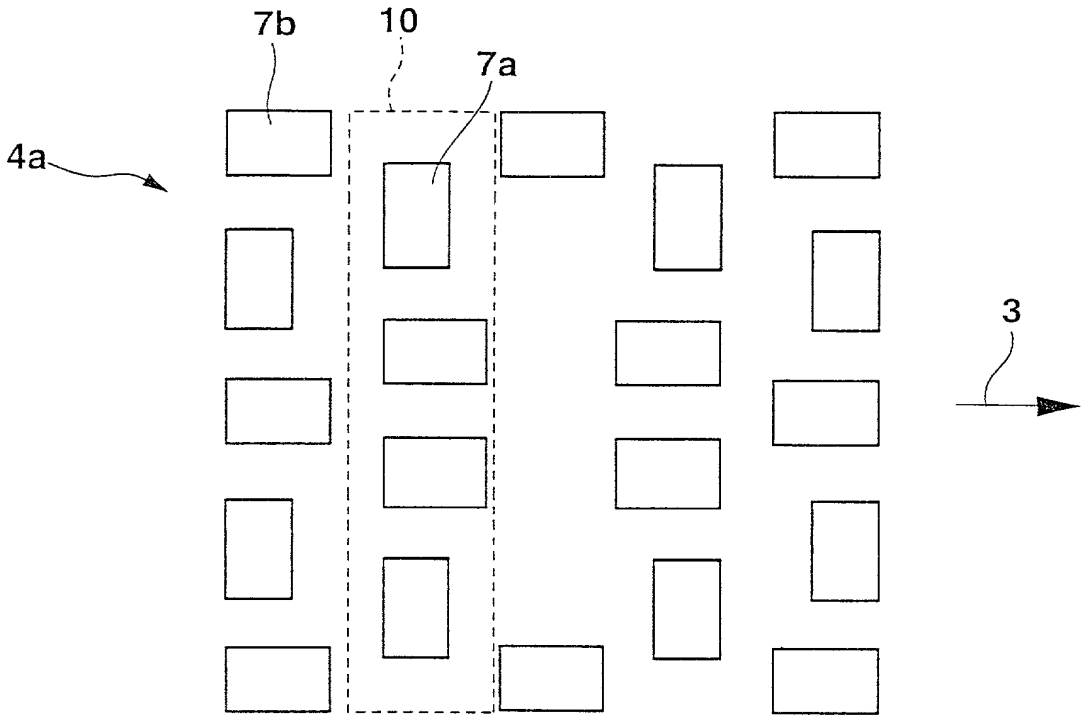


Fig. 3a

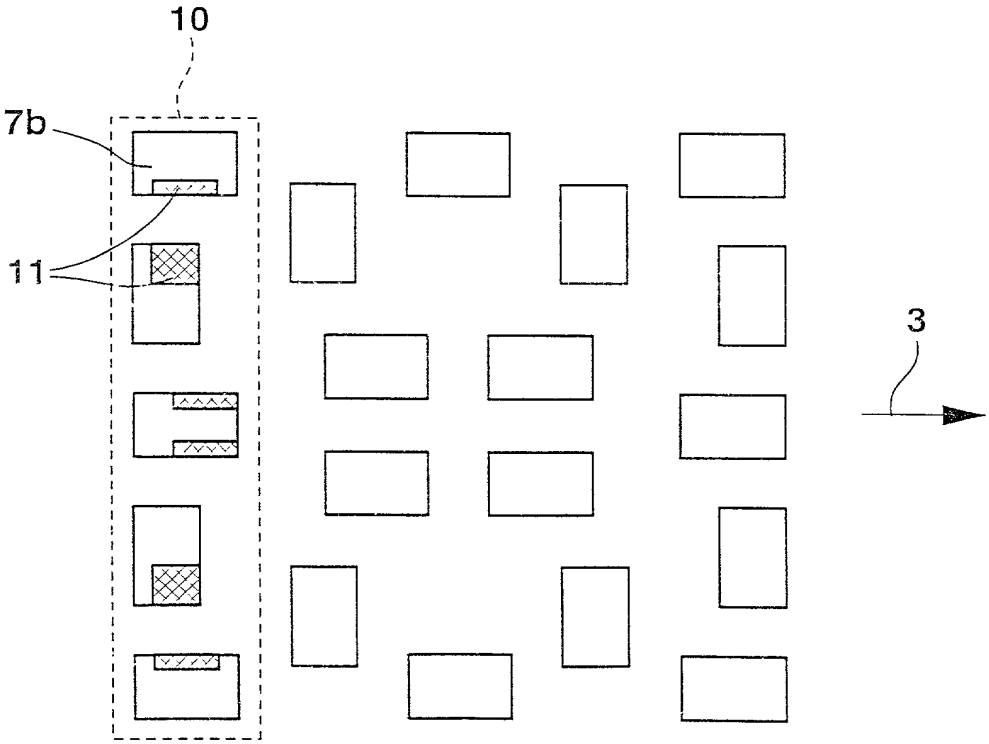


Fig. 3b

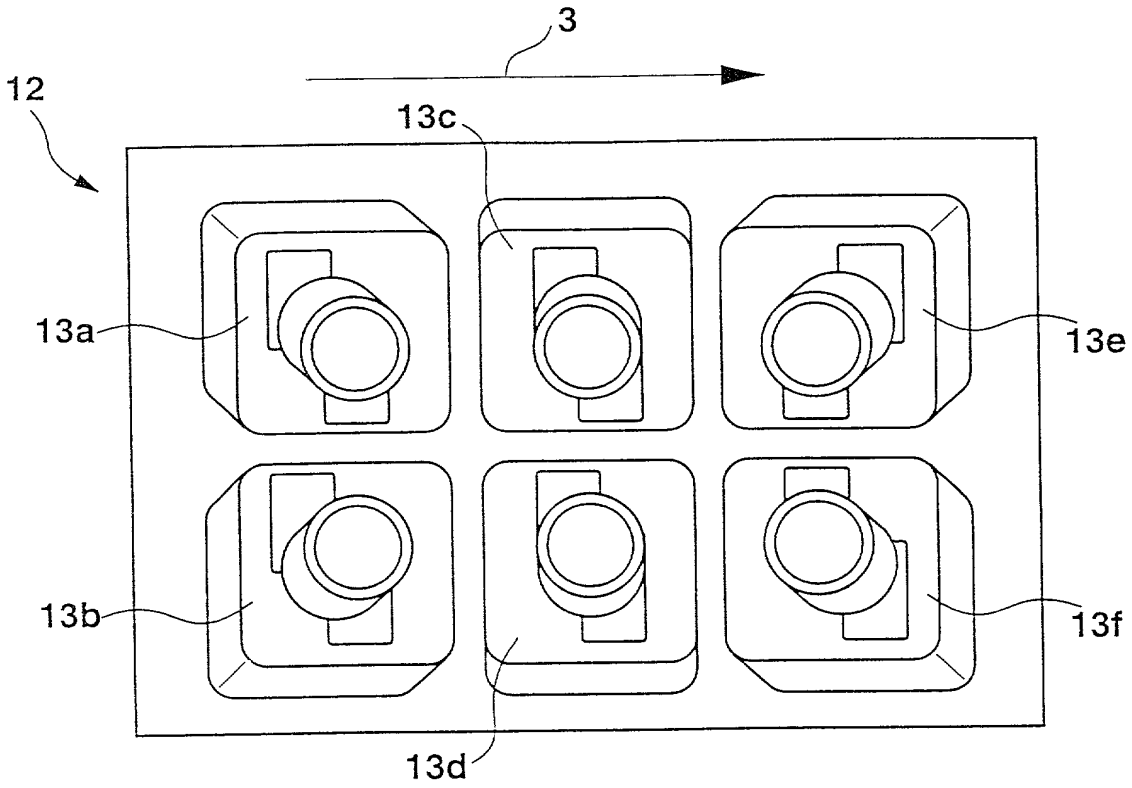


Fig. 4a

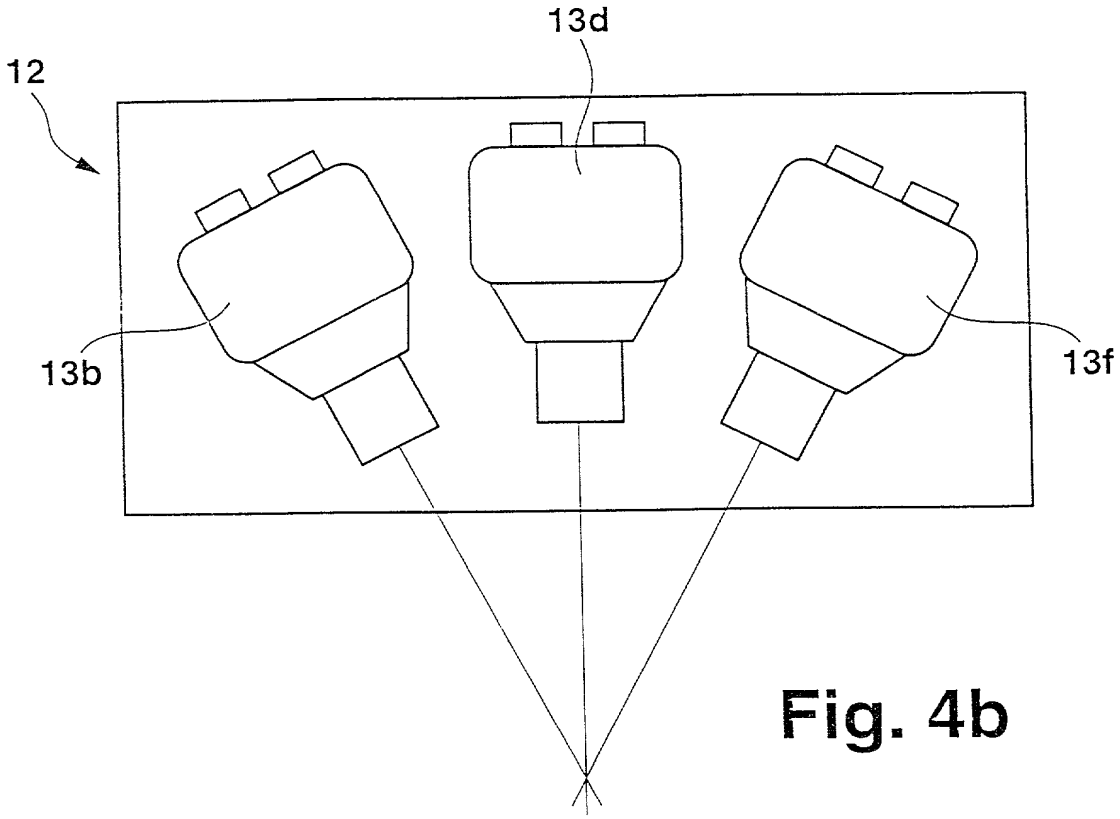


Fig. 4b

English translation
of original
application

5/prts

P7311PCT

Recording Method and Associated Photogrammetric Camera

The invention concerns a method for recording pictures, taken from the air, of terrain or a surface (industrial), in particular for air-based or space-based terrestrial picture recordings, wherein several individual pictures, taken from the air, of terrain or a surface region are successively electro-optically recorded and digitally stored and combined into a total picture of the terrain or surface region, and a photogrammetric camera for carrying out this method with several electro-optical detectors disposed to form at least one detector group.

A recording method of this type and such a photogrammetric camera have been disclosed e.g. in DE 197 14 396 A1.

DE 197 14 396 A1 discloses a photogrammetric camera wherein an electro-optical detector group is formed of immediately adjacent sensor lines (detectors) extending transverse to the direction of flight, with a series of individual picture elements or pixels. To obtain a total picture, linear terrain regions (terrain lines) are pictured on the sensor lines at different points in time. In contrast to a trilinear camera, the scanned terrain lines of this photogrammetric camera extend parallel to one another and directly join one another thereby principally improving the evaluation of the line pictures.

It is the object of the invention to further improve the recording method of the above-mentioned type and provide a photogrammetric camera for this purpose.

This object is achieved in accordance with the invention with the above-mentioned recording method in that the individual pictures record the complete terrain or surface region to be recorded thereby leaving different gaps and that for the total picture of the terrain or surface region, at least two individual pictures are digitally superposed by means of coinciding picture sections.

Preferably, at least two total pictures are recorded from a terrain or surface region each from a different perspective.

To combine several successive individual strip-like pictures, an electronic control permits overlapping of e.g. 50 pixels which permits assembly of same into a picture band in a geometrically stable and completely automatic fashion. This picture band assembly is

effected completely automatically for each perspective, e.g. to the front, rear and center (Nadir). A substantial distinctive feature between the invention and trilinear cameras consists in that in a conventional trilinear camera, two-dimensional partial pictures are already present and only these must be subjected to the orientation process. For partial picture stripes of a width of e.g. 1000 pixels, the orientation effort is reduced in accordance with the invention compared to the trilinear camera by the factor 1000 where theoretically each individual one-dimensional line would have to be subjected to the orientation process. This is not realized due to the costs, but with trilinear cameras so-called orientation lines are used for which the orientation parameters are exactly determined. For all intermediate lines, often several hundred lines, the orientation parameters are interpolated with more or less effort, i.e. only approximated orientation parameters are produced, with the trilinear camera, however, exact values. Moreover, the highly precise and expensive INS (InertialNavigationsSystems) units, which are used to support trilinear cameras, can be completely omitted. The two camera groups which are inclined to the front and rear thereby generate stereo picture pairs, whereas the Nadir cameras, disposed in the center, mediate the connection between the photogrammetric models at different locations and usually have a higher resolution. The latter is a decisive, advantageous distinction from the classical (so-called analog) serial photogrammetric cameras.

The basic difference compared to conventional evaluation systems consists also in that the digital pictures are evaluated in accordance with the invention automatically and, on a large scale, on the basis of algorithms. Consequently, the computer carrying out the evaluation must not necessarily obtain a joined digital individual aerial picture which was absolutely required with a classical serial photogrammetric camera. Computers „see" pictures in a mathematical and functional, however, not analog fashion. The computer system can consist of a frame, which is installed in an airplane and contains several industrial PCs. These PCs adopt the digital data from the electro-optical detector groups, supplement the required designations for the current picture block, format and store them e.g. on hard disk batches or tape drives.

To achieve the above-mentioned object, a photogrammetric camera is proposed wherein, in accordance with the invention, one detector group comprises several detectors separated from one another, wherein, viewed from a predetermined longitudinal direction (direction of flight) of the detector group, at least one detector covers at least part of the gap between two neighboring detectors spaced apart in the transverse direction.

While e.g. with the detector group known from DE 197 14 396 A1 whose entire surface is filled with sensor lines, i.e. with detectors, the inventive electro-optical detector group

can do with a smaller detector surface due to the gaps provided between neighboring detectors. This permits more simple production at reduced costs.

In preferred embodiments of the inventive photogrammetric camera, the neighboring detectors have a smaller separation from one another in the border regions of the detector group than in the center, wherein detectors in the border regions of the detector group can have a higher resolution than detectors in the center of the detector group.

Preferably, at least three electro-optical detector groups are provided in the direction of flight of which the central one is designed for color recordings and the two others for black/white recordings.

Preferably, the at least one detector group is attached to a camera known per se instead of a film tape. This camera attachment preferably rests on a base plate which can be attached instead of the film tape e.g. on a serial photogrammetric camera. This permits digital operation of conventional serial photogrammetric cameras at full performance thereby obtaining black/white and colored digital pictures. The camera attachment may bear the detectors which are mutually offset, as described above, and comprises only the actual sensor unit including detector group. The sensor electronics of the camera heads permits compensation of the flight motion (forward motion compensation, FMC) during the picture recording for CCD detectors of a certain construction type. This sensor-close electronics is combined in an electronic unit which can be mounted onto or next to the camera attachment. To obtain precise measurement of the line of sight of the camera, an optional inertial platform must be rigidly connected to the camera attachment. The essential advantage of the digital camera attachment including detector groups consists in the freedom with which the angle of view can be selected, i.e. the angle of the stereo basis which is determined by the outer detector groups to the front and rear.

The focal plane of the camera attachment can contain e.g. a total of 3 double rows including seven CCD detector groups each. The arrangement of the detectors comprising gaps in the direction of flight, facilitates accommodation of the CCDs with the associated sensor electronics in a casing and fully automatic assembly of the pictures of all detectors into a total picture later in the computer.

The photogrammetric camera can be formed as multi-head camera wherein one separate camera head is provided for each detector group. The outer camera heads contain black/white detectors for optimum performance during aerotriangulation whereas the Nadir camera located in the center is provided with color detectors which have a color

pattern e.g. in red, green and blue, e.g. Bayer pattern RGGB. This permits production of e.g. colored orthophotos of an optimum quality.

Further advantages of the invention can be extracted from the description and the drawing. The features mentioned above and below can be used in accordance with the invention either individually or collectively in any arbitrary combination. The embodiment shown and described is not to be understood as exhaustive enumeration but rather has exemplary character for describing the invention.

Fig. 1 schematically shows an embodiment of an inventive photogrammetric camera including three detector groups;

Fig. 2 shows different embodiments of detector groups;

Fig. 3 shows the recording situation of a terrain strip on the ground or of any surface segment at two different, but immediately following recording times; and

Fig. 4 shows a photogrammetric camera including six camera heads, viewed from below through the optical window (Fig. 4a) and their orientation transverse to the direction of flight (Fig. 4b).

Fig. 1 schematically shows an inventive photogrammetric camera 1 which is disposed in an aircraft (not shown) and flies in the direction of flight 3 over terrain 2 symbolically shown through the horizon. The camera 1 comprises three electro-optical detector groups 4a, 4b, 4c which are separated from one another in the direction of flight 3. The outer detector groups 4a, 4c are oriented to the front or rear and the central detector group 4b is oriented to the Nadir. One terrain region 6a, 6b, 6c is pictured on the individual detector groups 4a,4b,4c via a projection lens 5 which can consist of an array of individual objectives in accordance with Fig. 4.

As further explained below, each detector group 4 comprises several detectors 7 separated from one another (e.g. CCD detectors) which are disposed such that, viewed in the direction of flight 3, at least one detector 7 at least partly covers the gap 8 between two neighboring detectors separated from one another transverse to the direction of flight 2. At the moment shown in Fig. 1, the detector group 4a, 4b, 4c electro-optically records and stores the full surface of each terrain region 6a, 6b, 6c, however, the individual picture is incomplete due to the gaps 8 between the individual detectors 7. It is decisive that no picture connection of the individual detector groups 4a, 4b, 4c in the direction of flight 3 is required.

Fig. 2 shows three different embodiments of detector groups 41, 42, 43 with electro-optical detectors 7 of different arrangements which are each surrounded by a lateral outer border 9. The detectors 7 of the detector group 41 (Fig. 2a), viewed in the direction of flight 3, have a smaller separation from one another in their bordering region than at their center. This produces gaps 8 of different sizes which are larger in the center than in the border regions. The detectors 7 of the detector group 42 (Fig. 2b) are – compared to the detector group 41 – distributed more uniformly across their entire surface and, in particular, also disposed in their center. However, also the gaps 8 have different sizes. The detector group 43 (Fig. 2c) shows a completely uniform arrangement of the detectors 7 in the direction of flight 3 with identical gap pattern. While the detector groups 41 and 42 comprise 20 detectors 7 each, the detector group 43 has a total of 25 detectors 7.

In all detector groups 41,42,43, the detectors 7 are disposed in a loose, but calibrated arrangement and do no longer completely cover a strip extending transverse to the direction of flight 3. Detectors 7a and 7b neighboring in the direction of flight 3 are disposed next to one another thereby leaving a gap 8 such that, viewed in the direction of flight 3, at least one front detector 7a at least partially covers the gap 8 between two neighboring rear detectors 7b separated transverse to the direction of flight 2, or vice versa.

Fig. 3 shows that a certain strip of terrain 10 is pictured at a first point in time (Fig. 3a) onto the front detectors 7a of the detector group (e.g. 4a) disposed in the front detector strip extending transverse to the direction of flight 3 and are recorded and digitally stored as incomplete first individual picture. At a slightly later point in time (Fig. 3b), when the detector group 4a has moved forward in the direction of flight 3, this terrain strip 10 is again recorded by the detector group 4a as incomplete second individual picture, however by the rear detectors 7b and digitally stored. Since the rear detectors 7b leave a gap to the front detectors 7a in the direction of flight 3, the two individual pictures comprise coinciding picture sections 11 of the terrain strip 10 by means of which the two individual pictures can be aligned to each other and superposed into a digital total picture of the terrain strip 10.

Fig. 4 shows a multi-head camera 12 comprising six camera heads 13a to 13f of which one pair 13a, 13b is directed to the front, one pair 13c, 13d is directed to Nadir and one pair 13e, 13f is directed to the rear. A camera head (13a,13c,13e) of each pair is directed to the right, viewed in the direction of flight 3, and one (13b,13d,13d) is directed to the left. The outer camera heads 13a,13b and 13e,13f contain black/white

detectors for optimum performance at aerotriangulation, whereas the Nadir cameras 13c,13d disposed in the center are provided with color detectors which have a color pattern e.g. in red, green and blue, e.g. Bayer pattern RGGB. This permits production of e.g. colored orthophotos of optimum quality.

The essential advantage of the multi-head camera 12 – and the camera 1 – is the freedom of selection of the angle of view, i.e. the angle of the stereo basis which is determined by the inclination of the two outer camera groups to the front and rear. This produces the separation of the recorded picture groups on the ground and hence the number of successively recorded pictures of a series until the scene is completely covered. The partial pictures of the cameras disposed in a line, e.g. the front camera line, have an overlapping which can be determined by the camera arrangement such that a complete two-dimensional picture strip can be automatically produced at the front, rear and in the direction of the Nadir. It is thereby not required to provide complete picture overlapping of approximately 60% as it is the case in classical photogrammetry. Covering of approximately only 50 pixels for the picture connection is sufficient since the three camera groups assume the task of multiple overlapping. The two detector groups disposed to the front and rear thereby generate the stereo picture pairs whereas the Nadir detectors disposed in the center provide the connection between the photogrammetric models at different locations and provide colored orthophotos.

Of course, the multi-head camera can be provided with yet more camera heads, e.g. with nine or more camera heads, preferably in a pattern of 3 x 3.

In a method for recording pictures of terrain 2 from the air, wherein several individual aerial pictures of the terrain region 6a; 6b; 6c are successively electro-optically recorded and digitally stored, and combined into a total picture of the terrain region 6a;6b;6c, the individual pictures record the complete area of the terrain region 6a;6b;6c to be recorded, however, with different gaps 8, and at least two individual pictures are digitally superposed by means of coinciding picture sections 11 to obtain the entire picture of the terrain region 6a;6b;6c. Towards this end, a photogrammetric camera 1 with at least one detector group 4a, 4b, 4c is used which comprises several detectors 7 disposed at a separation from one another, wherein, viewed in the direction of flight 3, at least one detector 7 at least partially covers the gap 8 between two neighboring detectors 7 separated in the transverse direction.

Claims

1. Method for recording pictures of a terrain (2) or surface from the air, wherein several individual pictures of a terrain or surface region (6a;6b;6c), taken from the air, are successively electro-optically recorded and digitally stored, and combined into a total picture of the terrain or surface region (6a;6b;6c),
characterized in that
the individual pictures record the full area of the terrain or surface region (6a;6b;6c) to be recorded, however, with different gaps (8) and that at least two individual pictures are digitally superposed by means of coinciding picture sections (11) to obtain the entire picture of the terrain or surface region (6a;6b;6c).

2. Method according to claim 1, characterized in that at least two total pictures of a terrain or surface region (6a;6b;6c) are recorded each from a different perspective.

3. Photogrammetric camera (1;12) for the detection of terrain or surface with electro-optical detectors (7;7a;7b) disposed in at least one detector group (4;41;42;43), in particular for carrying out the recording method according to claim 1 or 2, characterized in that the detector group (4;41;42;43) has several separated detectors (7;7a;7b) and that, viewed in a certain longitudinal direction (direction of flight 3) of the detector group (4;41;42;43) at least one detector (7;7a;7b) covers at least part of the gap (8) between two neighboring detectors (7b;7a) separated in the transverse direction.

4. Photogrammetric camera according to claim 3, characterized in that neighboring detectors (7) of the detector group (4;41;42;43) have a smaller separation from one another in the border region than in the center.

5. Photogrammetric camera according to claim 3 or 4, characterized in that detectors (7) in the border regions of the detector group (4;41;42;43) have a higher resolution than detectors (7) in the center.

6. Photogrammetric camera according to any one of the claims 3 through 5, characterized in that at least three detector groups (4a,4b,4c) are disposed in the direction of flight (3) of which the central is designed for color recordings and the two others are designed for black/white recordings.

7. Photogrammetric camera according to any one of the claims 3 through 6, characterized in that the at least one detector group (4a,4b,4c) is attached to a camera, known per se, instead of a film tape.

8. Photogrammetric camera (multi-head camera 12) according to any one of the claims 3 through 7, characterized in that each detector group has its own camera head (13a-13d).

Abstract

In a method for recording pictures of terrain (2) from the air, wherein several individual aerial pictures of the terrain region (6a; 6b; 6c) are successively electro-optically recorded and digitally stored, and combined into a total picture of the terrain region (6a;6b;6c), the individual pictures record the complete area of the terrain region (6a;6b;6c) to be recorded, however, with different gaps (8), and at least two individual pictures are digitally superposed by means of coinciding picture sections (11) to obtain the entire picture of the terrain region (6a;6b;6c). Towards this end, a photogrammetric camera (1) with at least one detector group (4a, 4b, 4c) is used which comprises several detectors (7) disposed at a separation from one another, wherein, viewed in the direction of flight (3), at least one detector (7) at least partially covers the gap (8) between two neighboring detectors (7) separated in the transverse direction.

(Fig. 1)

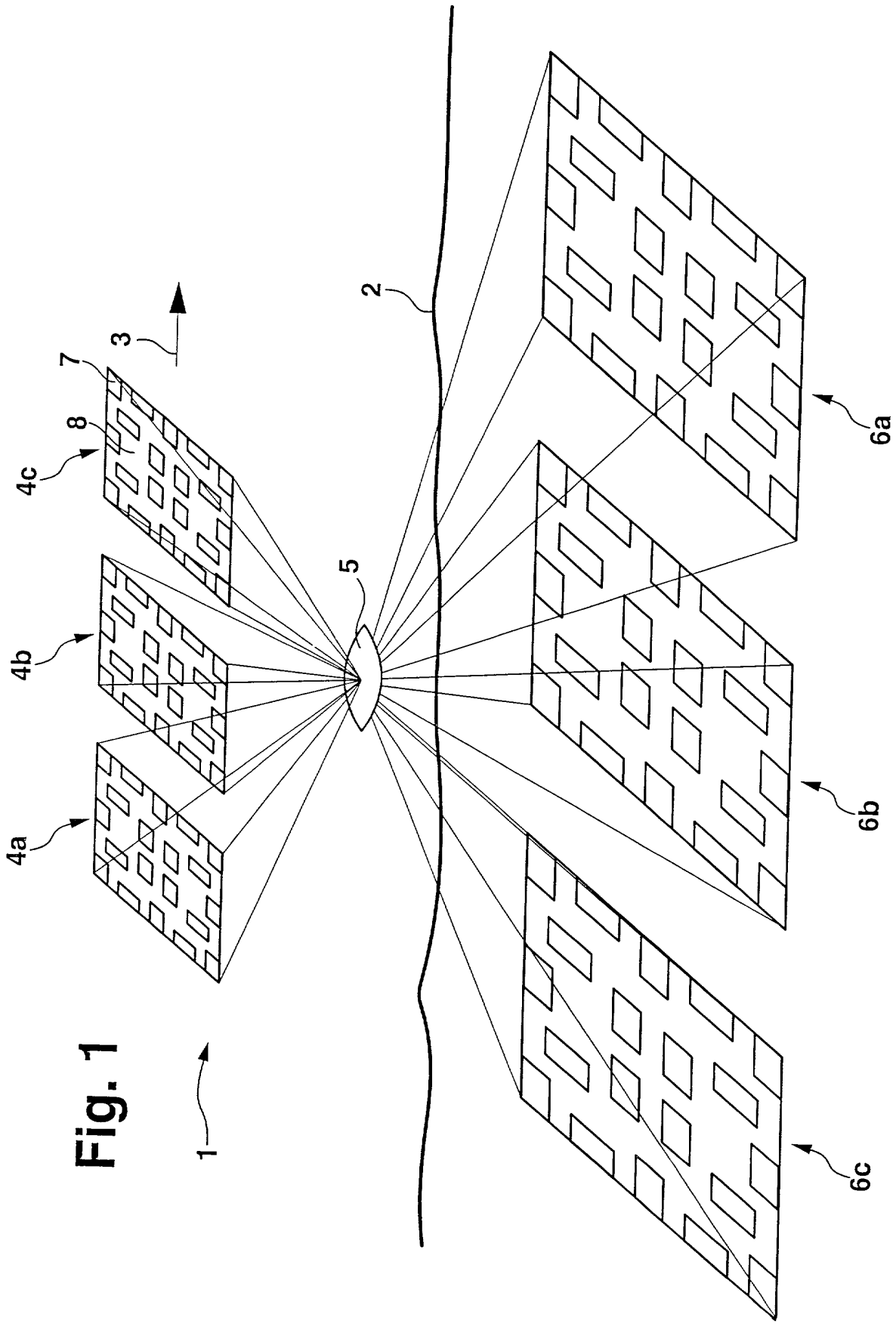


Fig. 1

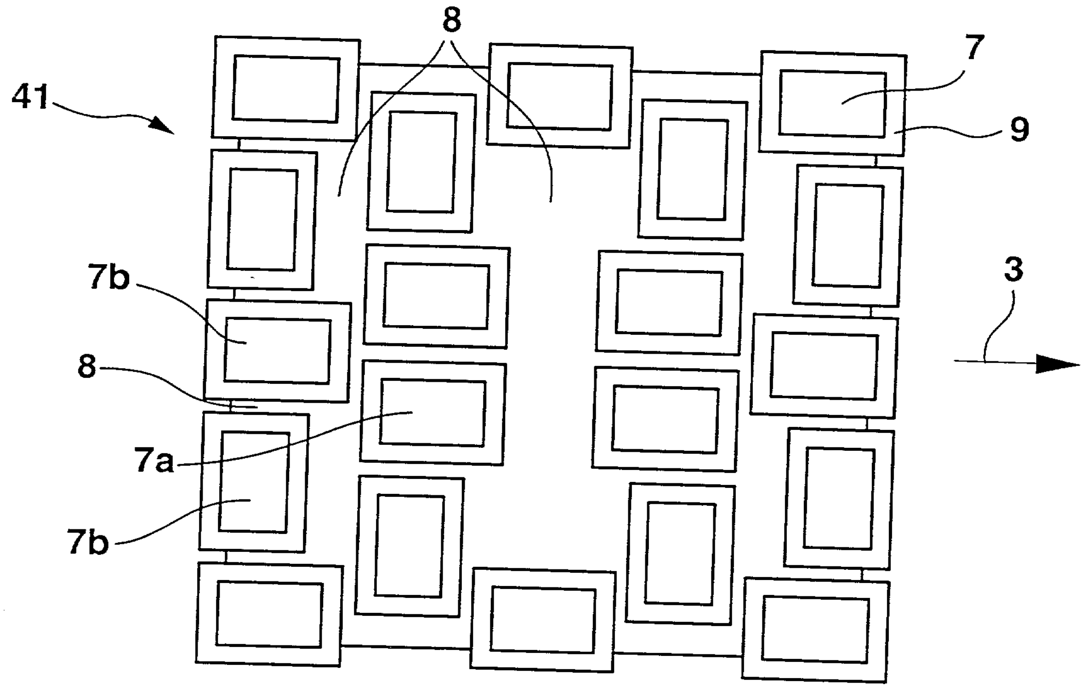


Fig. 2a

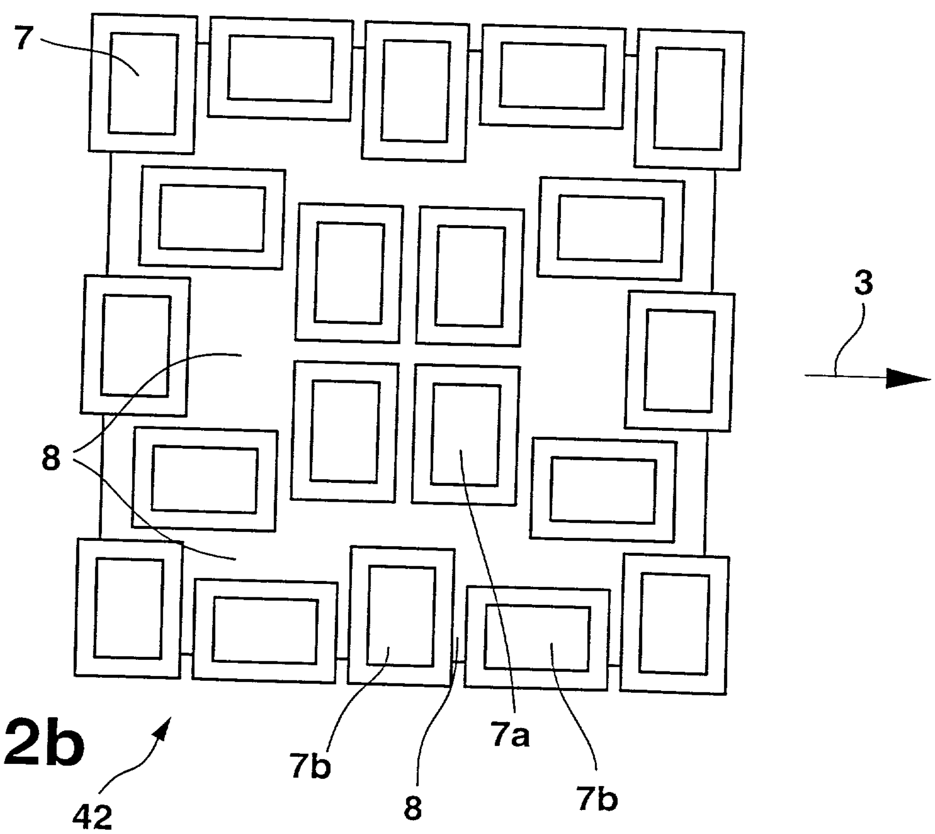


Fig. 2b

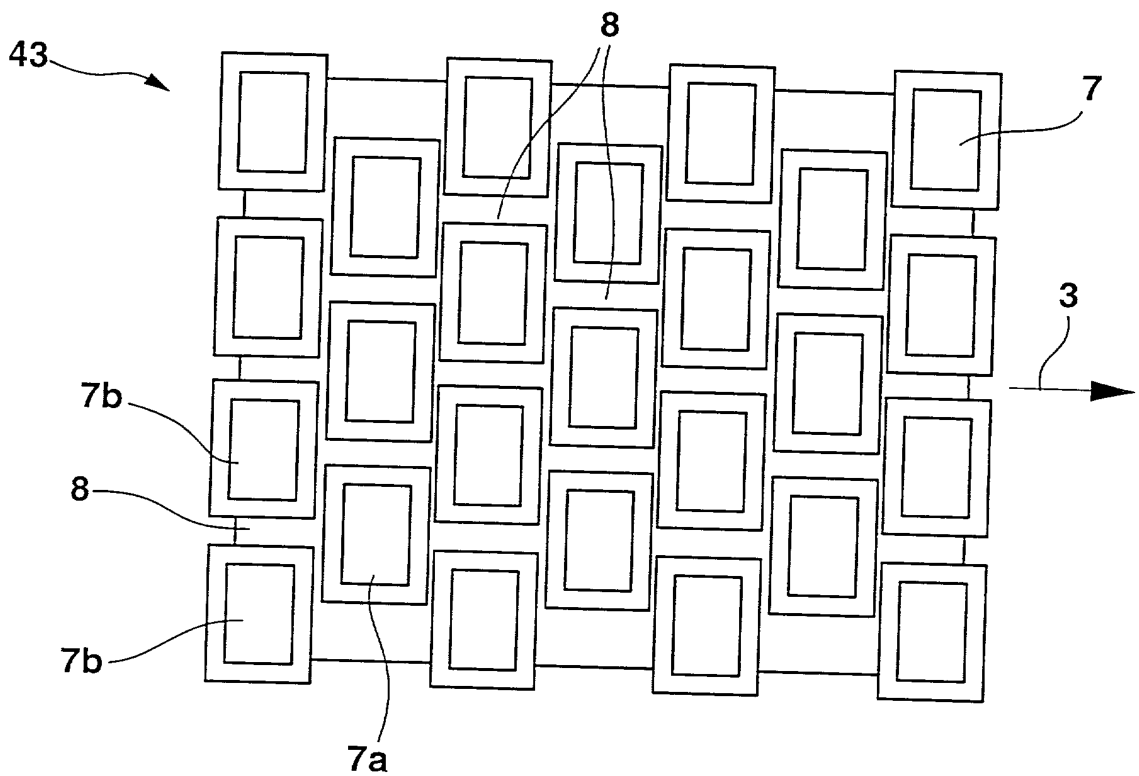


Fig. 2c

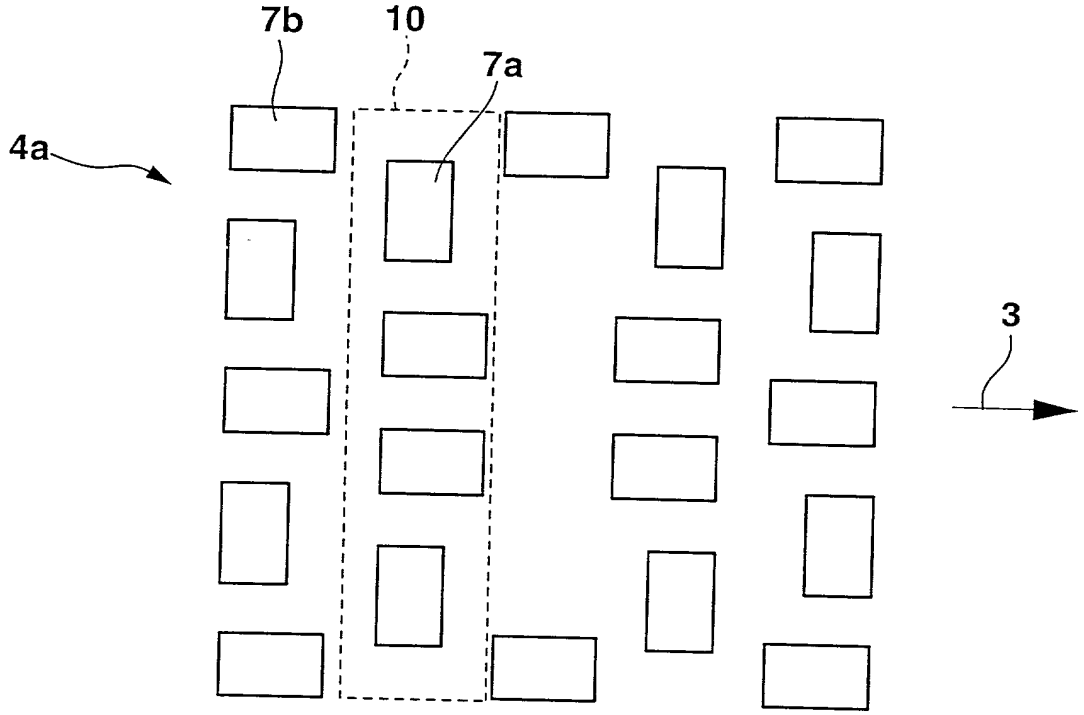


Fig. 3a

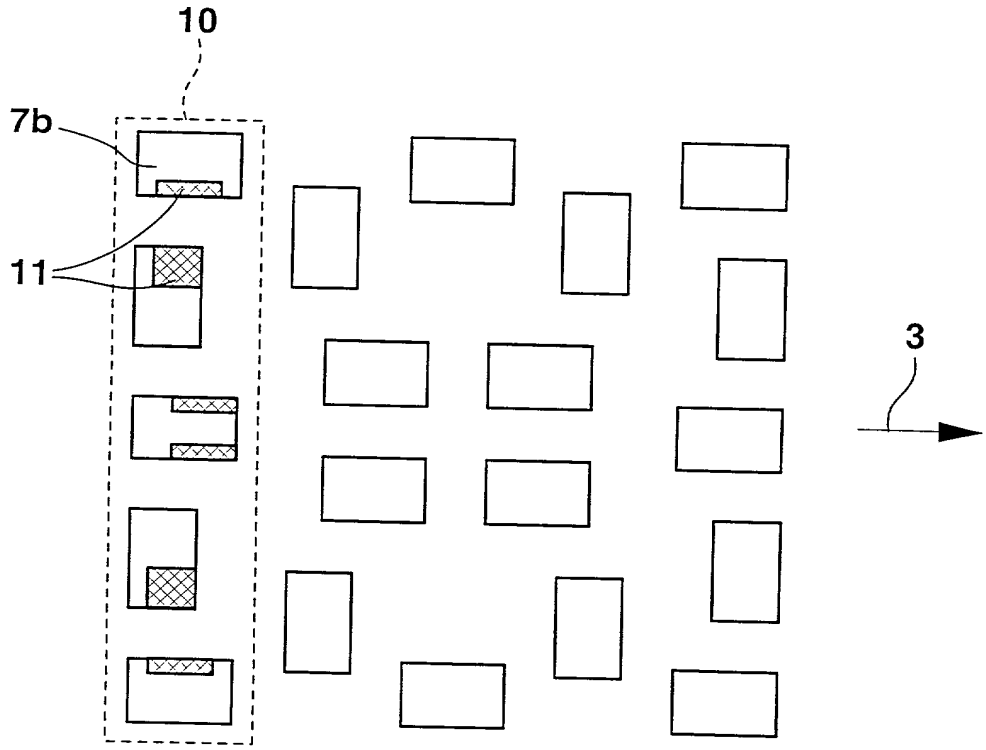


Fig. 3b

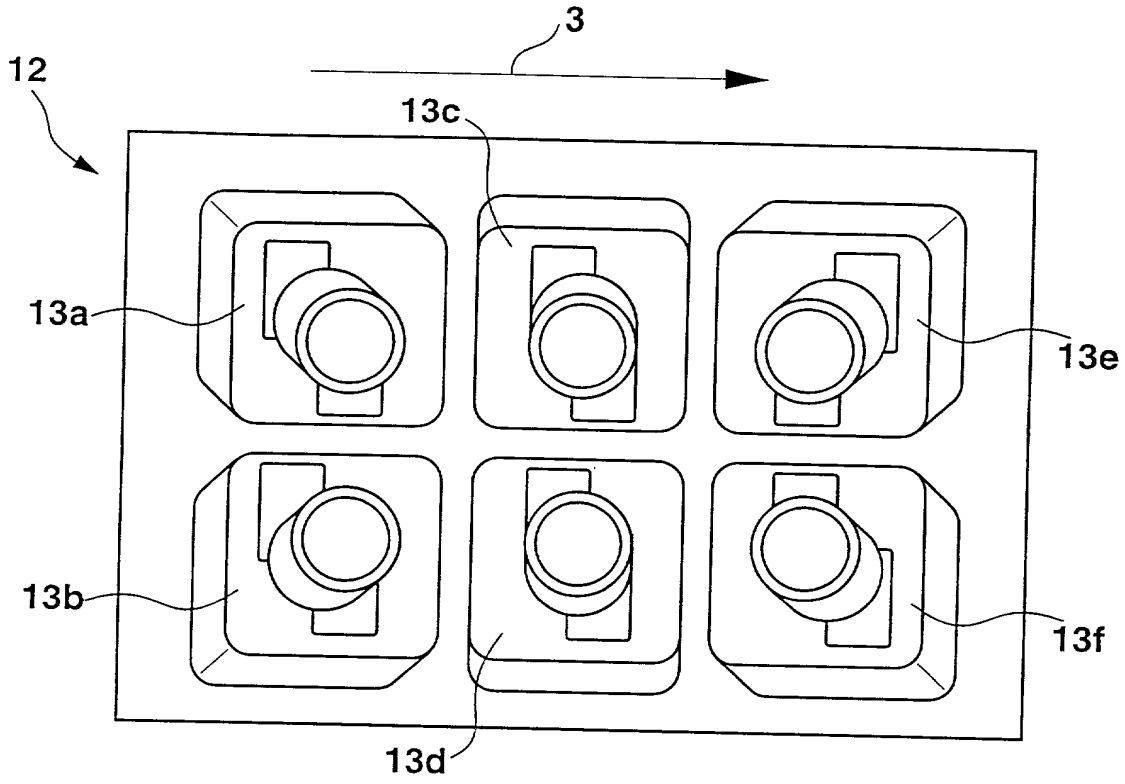


Fig. 4a

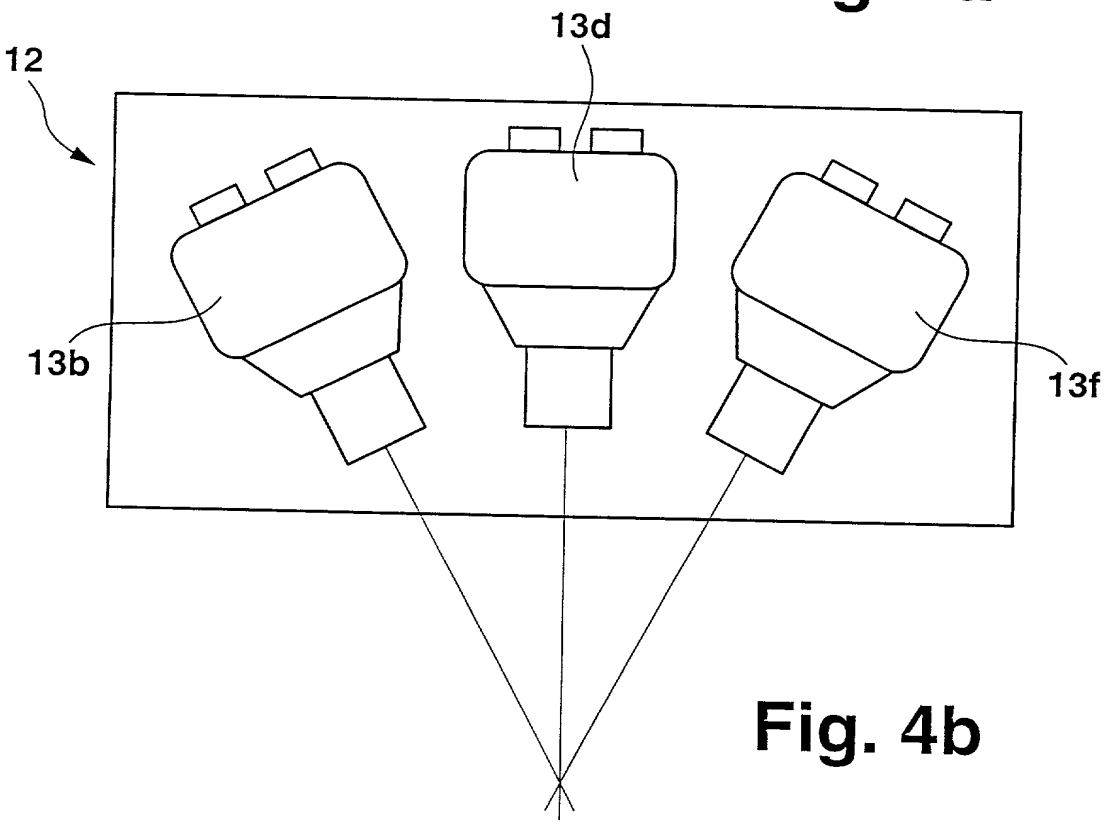


Fig. 4b

#4

Docket No.
2854

Declaration and Power of Attorney For Patent Application

English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled
RECORDING METHOD AND ASSOCIATED PHOTOGRAMMETRIC CAMERA

the specification of which

(check one)

☐ is attached hereto.

☒ was filed on 10/25/2001 as United States Application No. or PCT International Application Number 10/019,512

and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)			Priority Not Claimed
(Number)	(Country)	(Day/Month/Year Filed)	☐
(Number)	(Country)	(Day/Month/Year Filed)	☐
(Number)	(Country)	(Day/Month/Year Filed)	☐

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

(Application Serial No.)	(Filing Date)
(Application Serial No.)	(Filing Date)
(Application Serial No.)	(Filing Date)

I hereby claim the benefit under 35 U. S. C. Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, C. F. R., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

PCT/DE00/01163	**12 April 2000**	**Pending**
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

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